M16C/26

Using the A-D Converter In Repeat Sweep Mode 0

1.0 Abstract

The following document outlines the steps necessary to setup and perform analog to digital conversions of the M16C/26 using repeat sweep mode 0. The ADC is useful in measuring output voltages of sensors such as accelerometers or other analog instrumentation and converting them to digital values.

2.0 Introduction

The Renesas M30262 is a 16-bit MCU based on the M16C/60 series CPU core. The MCU features include up to 64K bytes of Flash ROM, 2K bytes of RAM and 4K bytes of Virtual EEPROM. The peripheral set includes 10-bit A/D, UARTS, Timers, DMA, and GPIO. The M16C/26 features an onboard analog to digital converter (ADC). The ADC consists of one 10-bit successive approximation circuit, eight analog input pins, selectable conversion clock speeds, sample and hold function, and several conversion modes. Table 1 shows the performance of the ADC and Figure 1 shows a diagram of the ADC block.

Table 1 ADC Performance

Item	Performance
Method of A-D Conversion	Successive approximation (capacitive coupling amplifier)
Analog input voltage	0V to AVcc (Vcc)
Operating clock f_{AD}	f_{AD}, f_{AD}2, f_{AD}3, f_{AD}4, f_{AD}6, or f_{AD}6 or f_{AD}12 where f_{AD}=f(Xin)
Resolution	8-bit or 10-bit (selectable)
Operating modes	One-shot mode, repeat, single sweep mode, repeat mode, repeat sweep mode 0 and repeat sweep mode 1.
Analog input pins	8 pins AN_0 to AN_7
A-D conversion start condition	Software trigger: A-D conversion starts when the A-D conversion start flag changes to “1” External trigger (can be retriggered): A-D conversion starts when the A-D conversion start flag is “1” and the AD_{TRG}/P15 input (shared with INT3) changes from “H” to “L”
Conversion speed per pin	Without sample and hold function 8-bit resolution: 49 f_{AD} cycles, 10-bit resolution: 59 f_{AD} cycles. With sample and hold function 8-bit resolution: 28 f_{AD} cycles, 10-bit resolution:33 f_{AD} cycles.

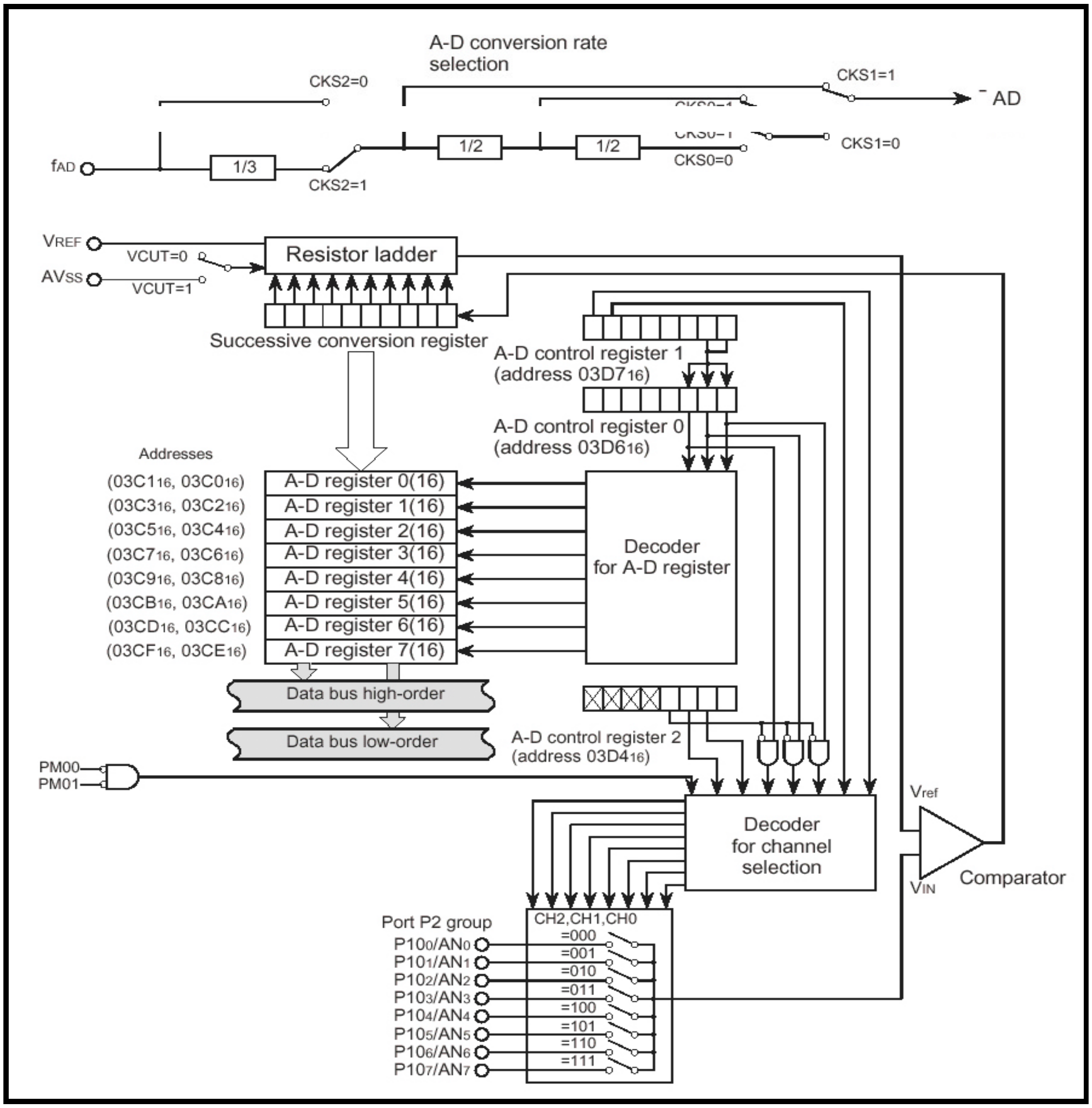

Figure 1 ADC Block Diagram

3.0 Repeat Sweep Mode 0 Description

In repeat sweep mode 0, several pins of the ADC can be selected as input sources. Once triggered, a conversion takes place on the selected pins and the result is stored in the ADC result registers corresponding to the selected channels. This is repeated until the ADC conversion start flag is disabled. No interrupt is generated on the completed conversions, but rather the ADC output registers are read anytime to determine the converted values. Below is an overview of the registers that will be used in this example. These registers are detailed in the included sample code. For specific details, consult the MCU datasheet. Figure 2 and Figure 3 show the control registers for ADC setup in Repeat Sweep Mode 0.

A-D control register 0 (Note)

b7	b6	b5	b4	b3	b2	b1	b0
			1	1			

Symbol ADCON0 — Address $03D6_{16}$ — When reset $00000XXX_2$

Bit symbol	Bit name	Function	R	W
CH0	Analog input pin select bit	Invalid in repeat sweep mode 0	O	O
CH1			O	O
CH2			O	O
MD0	A-D operation mode select bit 0	$\overline{b4\ b3}$ 1 1 : Repeat sweep mode 0	O	O
MD1			O	O
TRG	Trigger select bit	0 : Software trigger 1 : $\overline{AD_{TRG}}$ trigger	O	O
ADST	A-D conversion start flag	0 : A-D conversion disabled 1 : A-D conversion started	O	O
CKS0	Frequency select bit 0	Refer to table 1.18.2	O	O

Note: If the A-D control register is rewritten during A-D conversion, the conversion result is indeterminate.

A-D control register 1 (Note 1)

b7	b6	b5	b4	b3	b2	b1	b0
X	X	1			0		

Symbol ADCON1 — Address $03D7_{16}$ — When reset 00_{16}

Bit symbol	Bit name	Function	R	W
SCAN0	A-D sweep pin select bit	When repeat sweep mode 0 is selected $\overline{b1\ b0}$ 0 0 : AN_0, AN_1 (2 pins) 0 1 : AN_0 to AN_3 (4 pins) 1 0 : AN_0 to AN_5 (6 pins) 1 1 : AN_0 to AN_7 (8 pins)	O	O
SCAN1			O	O
MD2	A-D operation mode select bit 1	Set to 0 when this mode is selected	O	O
BITS	8/10-bit mode select bit	0 : 8-bit mode 1 : 10-bit mode	O	O
CKS1	Frequency select bit1	Refer to table 1.18.2	O	O
VCUT	Vref connect bit (Note 2)	1 : Vref connected	O	O
	Nothing is assigned. In an attempt to write to these bits, write 0. The value, if read, turns out to be 0.		O	O

Note 1: If the A-D control register is rewritten during A-D conversion, the conversion result is indeterminate.
Note 2: If the VCUT bit is reset from "0" (Vref unconnected) to "1" (Vref connected), wait for 1 μs or more before starting A-D conversion.

Figure 2 ADC control registers in Repeat Sweep Mode 0

A-D control register 2 (Note 1)

b7 b6 b5 b4 b3 b2 b1 b0: X X X _ 0 0 0 _

Symbol	Address	When reset
ADCON2	$03D4_{16}$	00_{16}

Bit symbol	Bit name	Function	R	W
SMP	A-D conversion method select bit	0 : Without sample and hold 1 : With sample and hold	O	O
Reserved bits		Must always be set to 0	O	O
CKS2	Frequency select bit 2	Refer to table 1.18.2	O	O
Nothing is assigned. In an attempt to write to these bits, write 0 . The value, if read, turns out to be 0 .			—	—

Note 1: If the A-D control register is rewritten during A-D conversion, the conversion result is indeterminate.

A-D register i

Symbol	Address	When reset
ADi(i=0 to 7)	$03C0_{16}$ to $03CF_{16}$	Indeterminate

(b15) b7 X X X X X X (b8) b0 | b7 b0

Function	R	W
Eight low-order bits of A-D conversion result	O	X
During 10-bit mode Two high-order bits of A-D conversion result	O	X
During 8-bit mode When read, the content is indeterminate	X	X
Nothing is assigned. In an attempt to write to these bits, write 0 . The value, if read, turns out to be 0 .	—	—

Figure 3 ADC Control Registers

4.0 Example Program

The following example program demonstrates how to perform a conversion using the ADC with the following configuration.

- Repeat sweep mode 0 conversions
- 10 bit mode
- Analog inputs 0-3 used
- Sample and hold enabled
- Internal Vref
- Conversion clock used will be $f_{AD}/4$ (When f(Xin) is greater than 10 MHz, f f_{AD} must be divided)
- Software conversion start

5.0 Reference

Renesas Technology Corporation Semiconductor Home Page

http://www.renesas.com

E-mail Support

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Data Sheets

- M16C/26 datasheets, M30262eds.pdf

User's Manual

- M16C/20/60 C Language Programming Manual, 6020c.pdf
- M16C/20/60 Software Manual, 6020software.pdf
- MSV30262-SKP or MSV-Mini26-SKP Quick start guide
- MSV30262-SKP or MSV-Mini26-SKP Users Manual
- MDECE30262 or MSV-Mini26-SKP Schematic

6.0 Software Code

The sample software provided was compiled using the KNC30 compiler. The program sets up the ADC to continuously perform conversions on channels 0 to 3. The code then repeatedly reads the results of those conversions. The example program was written to run on the MSV30262 Starter Kit but could be modified for a user application.

```
/**********************************************************************
*       DESCRIPTION: repeat_sweep_mode_0.c                            *
*                                                                      *
*       PURPOSE: Outlines how to use the M16C/26 ADC in repeat sweep   *
*          mode0. On reset, program repeatedly stores the result       *
*          of the conversion in a variable that can be examined        *
*          using KD30 or similar tool.                                 *
**********************************************************************/

#include "sfr26.h"
int TempStore0 = 0x0000;          // Location where ADC result is stored
int TempStore1 = 0x0000;          // Location where ADC result is stored

int TempStore2 = 0x0000;          // Location where ADC result is stored
int TempStore3 = 0x0000;          // Location where ADC result is stored

/*
```

```
 ** main
 *  PARAMETERS: None
 *  DESCRIPTION: Main function. Where program execution starts. Sets
 *                 up the ADC then reads conversion results.
 *  RETURNS: Nothing
 */

void main (void){
       adcon0 = 0x18;
                 /*
                 00011000;  /* AN0, repeat sweep mode 0, software trigger, fAD/4
                 ||||||||______Analog input select bit 0
                 |||||||_______Analog input select bit 1
                 ||||||________Analog input select bit 2
                 |||||_________A/D operation repeat mode select bit 0
                 ||||__________A/D operation repeat mode select bit 0
                 |||___________Trigger select bit
                 ||____________A/D conversion start flag
                 |_____________Frequency select bit 0  */

adcon1 = 0x29;
                 /*
                 00101001;  /* AN0 - AN3, 10 bit mode, fAD/4, Vref connected
                 ||||||||______A/D sweep pin select bit
                 |||||||_______A/D sweep pin select bit
                 ||||||________A/D operation mode select bit 1
                 |||||_________8/10-bit mode select bit
                 ||||__________Frequency select bit 1
                 |||___________Vref connect bit - connected
                 ||____________reserved
                 |_____________reserved

adcon2 = 0x01;
                 /*
                 00000001;  /* Sample and hold enabled
                 ||||||||______sample and hold select bit
                 |||||||_______reserved
                 ||||||________reserved
                 |||||_________reserved
                 ||||__________Frequency select bit 2
                 |||___________reserved
                 ||____________reserved
                 |_____________reserved */

 adic = 0x01;
                 /*
                 00000001;  /* Enable the ADC interrupt
                ||||||||______interrupt priority select bit 0
                 |||||||_______interrupt priority select bit 1
                 ||||||________interrupt priority select bit 2
                 |||||_________interrupt request bit
                 ||||__________reserved
                 |||___________reserved
                 ||____________reserved
                 |_____________reserved */
```

```
    _asm ("   fset i") ;            // globally enable interrupts

    adst = 1;                // Start a conversion here

    while (1){
       TempStore0= ad0 & 0x03ff;         // Mask off the upper 6 bits of the
                                         // variable leaving only the result
                                         // in the variable itself

       TempStore1= ad1 & 0x03ff;         // Mask off the upper 6 bits of the
                                         // variable leaving only the result
                                         // in the variable itself

       TempStore2= ad2 & 0x03ff;         // Mask off the upper 6 bits of the
                                         // variable leaving only the result
                                         // in the variable itself

       TempStore3= ad3 & 0x03ff;         // Mask off the upper 6 bits of the
                                         // variable leaving only the result
                                         // in the variable itself
}
}
```

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